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AGRICULTURE & FORESTRY SECTOR GHG REDUCTION POLICY OPTIONS

PREPARED FOR TWG CALL #5, NOVEMBER 17, 2005

Potential Emission Reductions *	Potential Cost or Cost Savings *
High (H): At least 1 Million Metric Tons (MMT) carbon dioxide equivalent (CO ₂ e) per year by 2020 (~1% of current AZ emissions)	High (H): \$50 per Metric Ton CO ₂ e (MTCO ₂ e) or above
Medium (M): From 0.1 to 1 MMT CO ₂ e per year by 2020	Medium (M): \$5-50/MTCO ₂ e
Low (L): Less than 0.1 MMT CO ₂ e per year by 2020	Low (L): Less than \$5/MTCO ₂ e
Uncertain (U): Not able to estimate at this time	Cost Savings: Options that save money, i.e., that have "negative costs."
	Uncertain (U): Not able to estimate at this time

* "Potential" here connotes rough initial estimate based in part on experience in other states. Also, several measures may overlap in terms of emissions reductions and/or cost impacts. Estimates assume measures would be implemented independently from other measures.

Definition of Priorities for Analysis:

- **High:** High priority options will be analyzed first.
- **Medium:** Medium priority options will be analyzed next, time and resources permitting.
- **Low:** Low priority options will be analyzed last, time and resources permitting.

** Options marked with a double asterisk (**) indicate options that are at least partially "base case" policies, i.e., that have been or are likely to be implemented at some level in Arizona.

Comments or priorities highlighted in yellow were discussed and affirmed during the Arizona Climate Change Advisory Group (CCAG) Meeting on September 29, 2005. CCAG meeting summary is posted at:
<http://www.azclimatechange.us/ewebeditpro/items/O40F7161.pdf>

Option No.	GHG Reduction Policy Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
	Agriculture – Production of Fuels and Electricity					
1.1	Manure Digesters (methane recovery and electricity production)	High	Medium	Neg to Low	<ul style="list-style-type: none"> Linked with Option 2.2 below 	•
1.2	Biodiesel Production (incentives for feedstocks and production plants)	Medium	Medium	Med to High	<ul style="list-style-type: none"> Production from both virgin and waste vegetable oils; Seed oil production in AZ feasible (e.g. soy and rapeseed)? 	
1.3	Biomass Feedstocks for Electricity or Steam Production	High	Low	?	<ul style="list-style-type: none"> Need to identify viable feedstocks and volumes [e.g., crop residue (wheat straw, corn stover) or energy crops (switchgrass); Linkage to Energy Supply TWG to determine availability of biomass plants Linkage to RCI TWG to identify available capacity for biomass generated steam 	1.
1.4	Ethanol Production	High	Medium	Med to High	<ul style="list-style-type: none"> Current debate on the energy required for ethanol production 	•

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1.5	Convert Diesel Farm Equipment to LNG/CNG or Hybrid Technology	Medium	Low	Med to High	<ul style="list-style-type: none"> LNG/CNG engines or engine conversions reduce BC emissions Availability of diesel hybrid equipment for farm applications? 	•
1.6	(Additional option, if/as suggested)				•	•
1.7	(Additional option, if/as suggested)				•	•
Agriculture – Fertilizer and Manure Management						
2.1	Nutrient Management (improve efficiency of fertilizer use)	Medium	Medium	Low	<ul style="list-style-type: none"> Note Ag. Best Management Practices under ARS §49-457 (do these extend beyond dust control and water efficiency measures?) Linked to Option 3.4 below. 	•
2.2	Manure Management (practices to reduce methane emissions)	High	Medium	?	<ul style="list-style-type: none"> Linked with Option 1.1 above. Existing waste containment requirements for animal feeding operations > or = 1,000 head. Could include composting and other measures. Most of the benefit achieved at dairies. Co-benefits include reduction of ammonia and VOC emissions. 	

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2.3	Change Feedstocks (optimize nitrogen for N ₂ O reduction)	High	Low to Medium	Low	<ul style="list-style-type: none"> Most of the benefit achieved at feedlots. Co-benefits include reduction in ammonia emissions. 	2.
2.4	Reduce Non-Farm (Residential and Commercial) Fertilizer Use	High	?	?	<ul style="list-style-type: none"> Emissions from non-farm application are not currently in the inventory; unclear what the reductions and costs would be. 	•
2.5	(Additional option, if/as suggested)				•	•
2.6	(Additional option, if/as suggested)				•	•
Agriculture – Soil Carbon Management						
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)	Medium	Medium	Low	<ul style="list-style-type: none"> Boll Weevil eradication program requires cotton residue to be plowed under (conservation tillage not applicable to cotton) 	•
3.2	Reduce Summer Fallow (increase soil C content, reduce N ₂ O emissions)	Low	?	?	<ul style="list-style-type: none"> Applicability to AZ? Need estimates of fallow summer acreage 	
3.3	Increase Winter Cover Crops (increase soil C content, increase soil N content)	High	?	?	<ul style="list-style-type: none"> Applicability to AZ? Need estimates of winter acreage available for cover crops 	3.
3.4	Improve Water and Nutrient Use (to minimize soil C loss)	High	Low	Low	<ul style="list-style-type: none"> Linked to Option 2.1 above; Suggest combining these two. 	•

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3.5	Rotational Grazing/Improve Grazing Crops and/or Management	High	Low	Low	• Applicability to AZ?	•
3.6	(Additional option, if/as suggested)				1	•
Agriculture – Land Use Change						
4.1	Convert Land to Grassland or Forest	High	Medium	?	2 Opportunities for conversion in AZ?	•
4.2	Reduce Permanent Conversion of Farm and Rangelands to Developed Uses	High	High	?	<ul style="list-style-type: none"> • Reductions occur both from higher retention of carbon in soil and lower transportation activity. • Linked to Option 4.3. • Linked to Smart Growth Options in the TLU TWG. 	•
4.3	(Additional option, if/as suggested)				3	•
4.4	(Additional option, if/as suggested)				4	•
Agriculture – Farming Practices						
5.1	Organic Farming	Med	Medium	Low	<ul style="list-style-type: none"> • Reductions occur via lower intensity agricultural practices (nutrient/pesticide application, reduced tillage) 	<ul style="list-style-type: none"> • Weed management • Transgenic crops • Integrated pest management • Bed/row size or spacing • Application efficiencies (low volume sprayers, etc.)
5.2	Programs to Support Local Farming/Buy Local	High	Medium	?	<ul style="list-style-type: none"> • Reductions occur through lower transport related emissions. 	• Arizona Grown Program
5.3	(Additional option, if/as suggested)				5	•
5.4	(Additional option, if/as suggested)				6	•
Forestry – Biomass Protection and Management						

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6.1	Forest Protection – Reduced Clearing And Conversion to Nonforest Cover	High	High	Low	7 depends on business as usual rates of land clearing and viable alternatives	•
6.2	Increase Maintenance of Urban and Residential Trees	High	Low	Low to high	•	•
6.3	Afforestation of Nonforested Rural Lands	Low	Low to high	Low	• depends on available acreage and risk	•
6.4	Afforestation of Nonforested Urban Lands	Low	Low to high	Low	• depends on available acreage and risk	•
6.5	Reforestation/Restoration of Forested Lands	High	Low to high	Low	• depends on available acreage and risk	•
6.6	Reforestation or Increased Densification of Stands	Low	Low to high	Low	• depends on available acreage and risk	•
6.7	Age Extension of Managed Stands	High	Low	Low to high	• involves significant tradeoffs with carbon savings from harvested wood products, as well as ecological risk	•
6.8	Thinning and Density Management of Managed Stands	High	High	Low to high	• cost and technology barriers to market use of harvested biomass may be high; supply potential is high	•
6.9	Fertilization and Waste Recycling	Med	Low	Low to high	• site and situation specific	•
6.10	Expand Short Rotation Woody Crops (for fiber and energy)	Low	Low to medium	Low to high	• depends on available acreage and market demand	•
6.11	Expanded Use of Genetically Preferred Species	Low	Low	Low	• primary issues in the southwest are reductions of fuel load and restoration of native species	•

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6.12	Modified Biomass Removal Practices (reduced decay and energy use)	High	Low	?	<ul style="list-style-type: none"> may be opportunities to use biofuels for equipment 	<ul style="list-style-type: none">
6.13	Fire Management and Risk Reduction Programs	High	High	Low to high	<ul style="list-style-type: none"> implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse 	<ul style="list-style-type: none">
6.14	Ecosystem Health Risk Reduction Programs (pest/disease, invasive species)	High	High	Low to high	<ul style="list-style-type: none"> implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse 	<ul style="list-style-type: none">
6.15	Drought Management Programs (tree selection, placement, protection)	High	High	Low to high	<ul style="list-style-type: none"> implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse 	<ul style="list-style-type: none">
6.16	Flood and Riparian Management Programs (tree selection, placement, protection)	High	Low	Low to high	<ul style="list-style-type: none"> depends on available acreage 	<ul style="list-style-type: none">
6.17	Watershed Management Programs (stand retention, enhancement and management)	High	Low to high	Low to high	<ul style="list-style-type: none"> depends on available acreage and forest health issues 	<ul style="list-style-type: none">
6.18	Habitat Management Programs (stand retention, enhancement and management)	High	Low to high	Low to high	<ul style="list-style-type: none"> depends on available acreage and forest health issues 	<ul style="list-style-type: none">

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6.19	Re-conversion of woodlands to grasslands (e.g. pinon pine and juniper encroachment)	High	TBD	TBD	<ul style="list-style-type: none"> what are the carbon implications of wood/shrubland conversion from grasslands? Not all TWG members think this is a high priority 	
6.20	(Additional option, if/as suggested)					
	Forestry - Wood Products and Waste					
7.1	Improved Mill Waste Recovery	High	Low to high	Low to high	<ul style="list-style-type: none"> technology and market dependent 	
7.2	Improved Logging Residue Recovery	High	High	Low to high	<ul style="list-style-type: none"> technology and market dependent 	
7.3	Expanded Use of Small Diameter Trees for Wood Products and Energy	High	High	Low to high	<ul style="list-style-type: none"> technology and market dependent 	
7.4	Expanded Use of Wood Products for Building Materials	High	Medium to high	Low to high	<ul style="list-style-type: none"> technology and market dependent 	
7.5	Expanded Use of State and Locally-Grown Wood Products	High	Low to high	Low to high	<ul style="list-style-type: none"> technology and market dependent 	
7.6	(Additional option, if/as suggested)					
7.7	(Additional option, if/as suggested)					
	Forestry – Energy Production					
8.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching)	High	High	Low	<ul style="list-style-type: none"> technology and market dependent 	
8.2	Improve Use and Efficiency of Wood for Direct Commercial Heat and Energy	High	High	Low	<ul style="list-style-type: none"> technology and market dependent 	
8.3	Improved Energy Capture from Wood Waste Combustion	High	Low to high	?	<ul style="list-style-type: none"> technology and market dependent 	

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8.4	Expanded Landfill Methane Recapture (wood products waste)	High	Low	Neg to Low	<ul style="list-style-type: none"> Federal New Source Performance Standards and Emissions Guidelines require methane capture at larger landfills. 	<ul style="list-style-type: none">
8.5	Improved Commercialization of Biomass Gasification and Combined Cycle	High	Low to high	Medium to high	<ul style="list-style-type: none"> requires improved technology and market incentives 	<ul style="list-style-type: none">
8.6	Expand Usage and or Efficiency of Wood Waste as Residential Fuel Source	High	Low - Medium	Low	<ul style="list-style-type: none"> Overlap with RCI sector. 	<ul style="list-style-type: none">
8.7	(Additional option, if/as suggested)				<ul style="list-style-type: none"> 	<ul style="list-style-type: none">